CLAIMS

What is claimed is:

1. An apparatus, comprising:

a first optical waveguide disposed in a first semiconductor material of a semiconductor layer, the first optical waveguide including an inverted tapered inner core disposed in an untapered outer core of the first optical waveguide, wherein the inverted tapered inner core includes a smaller end and a larger end; and

a second optical waveguide disposed in a second semiconductor material of the semiconductor layer, wherein the second optical waveguide is a tapered optical waveguide having a larger end and a smaller end, wherein the larger end of the second optical waveguide is disposed proximate to the larger end of the inverted tapered inner core of the first optical waveguide such that an optical beam is to be directed from the smaller end to the larger end of the first optical waveguide to the larger end to the smaller end of the second optical waveguide.

2. The apparatus of claim 1 wherein the inverted tapered core of the first optical waveguide has an index of refraction that is greater than an index of refraction of the untapered outer core of the untapered outer core.

3. The apparatus of claim 1 further comprising an antireflective region disposed in the semiconductor layer between the larger end of the second optical waveguide and the larger end of the inverted tapered inner core of the first optical waveguide.

4. The apparatus of claim 3 wherein the antireflective region has an index of refraction that is in between an index of refraction of the inverted tapered core of the first optical waveguide and an index of refraction of the second optical waveguide.

5. The apparatus of claim 1 further comprising a third optical waveguide disposed in the second semiconductor material in the semiconductor layer, the third optical waveguide optically coupled to the smaller end of the second optical waveguide such that the optical beam is directed from the smaller end of the second optical waveguide into the third optical waveguide.

6. The apparatus of claim 5 wherein the second and third optical waveguides have substantially equal indexes of refraction.

7. The apparatus of claim 5 wherein the second and third optical waveguides are rib waveguides disposed in the semiconductor layer.

8. The apparatus of claim 1 wherein the first semiconductor material includes silicon oxynitride (SiON) and the second semiconductor material includes silicon (Si).

9. The apparatus of claim 3 wherein the antireflective region includes silicon nitride (Si_3N_4).

10. The apparatus of claim 1 wherein a tip width of the smaller end of the inverted tapered inner core of the first optical waveguide is less than a tip width of the smaller end of the second optical waveguide.

11. A method, comprising:

directing an optical beam into an untapered outer core of a first optical waveguide disposed in first semiconductor material in a semiconductor layer;

directing the optical from the untapered outer core of a first optical waveguide into an inverted tapered inner core of the first optical waveguide disposed in the first semiconductor material in the semiconductor layer as the optical beam propagates along the first optical waveguide from a smaller end to a larger end of the inverted tapered inner core of the first optical waveguide; and

directing the optical beam from the larger end of the inverted tapered inner core of the first optical waveguide into a second optical waveguide

disposed in a second semiconductor material of the semiconductor layer, wherein the second optical waveguide is a tapered optical waveguide having a larger end and a smaller end, wherein the optical beam is directed into larger end of the second optical waveguide.

12. The method of claim 11 further comprising directing the optical beam from the smaller end of the second optical waveguide into a third optical waveguide in the second semiconductor material of the semiconductor layer.

13. The method of claim 11 further comprising shrinking a mode size of the optical beam by directing the optical beam into the untapered outer core of a first optical waveguide and then directing the optical beam from the larger end of the inverted tapered inner core of the first optical waveguide.

14. The method of claim 12 further comprising shrinking a mode size of the optical beam by directing the optical beam into the larger end of the second optical waveguide and then directing the optical beam from the smaller end of the second optical waveguide.

15. The method of claim 11 wherein directing the optical from the untapered outer core of the first optical waveguide into the inverted tapered

inner core of the first optical waveguide comprises directing the optical beam from a material having a lower index of refraction into a material having a higher index of refraction.

16. The method of claim 11 further comprising directing the optical beam through an antireflective region when directing the optical beam from the larger end of the inverted tapered inner core of the first optical waveguide into the larger end of the second optical waveguide.

17. The method of claim 16 wherein directing the optical beam through the antireflective region when directing the optical beam from the larger end of the inverted tapered inner core into the larger end of the second optical waveguide comprises directing the optical beam through a region having an index of refraction value that is between index of refraction values of the first and second semiconductor materials.

18. A system, comprising:

an optical transmitter to transmit an optical beam;

an optical receiver;

an optical device disposed between the optical transmitter and the optical receiver, the optical device including:

a first optical waveguide disposed in a first semiconductor material of a semiconductor layer, the first optical waveguide

including an inverted tapered inner core disposed in an untapered outer core of the first optical waveguide, wherein the inverted tapered inner core includes a smaller end and a larger end; and

a second optical waveguide disposed in a second semiconductor material of the semiconductor layer, wherein the second optical waveguide is a tapered optical waveguide having a larger end and a smaller end, wherein the larger end of the second optical waveguide is disposed proximate to the larger end of the inverted tapered inner core of the first optical waveguide such that an optical beam is to be directed from the smaller end to the larger end of the first optical waveguide to the larger end to the smaller end of the second optical waveguide; and

a photonic device disposed in the second semiconductor material in the semiconductor layer optically coupled to the smaller end of the second optical waveguide, the optical beam coupled to be received by the photonic device through the first and second optical waveguides, the optical beam to be directed through the photonic device to the optical receiver.

19. The system of claim 18 further comprising an optical fiber optically coupled between the optical transmitter and the first optical waveguide.

20. The apparatus of claim 18 wherein the inverted tapered core of the first optical waveguide has an index of refraction that is greater than an index of refraction of the untapered outer core of the untapered outer core.

21. The apparatus of claim 18 further comprising an antireflective region disposed in the semiconductor layer between the larger end of the second optical waveguide and the larger end of the inverted tapered inner core of the first optical waveguide.

22. The apparatus of claim 21 wherein the antireflective region has an index of refraction that is in between an index of refraction of the inverted tapered core of the first optical waveguide and an index of refraction of the second optical waveguide.

23. The apparatus of claim 18 further comprising a third optical waveguide disposed in the second semiconductor material in the semiconductor layer, the third optical waveguide optically coupled between the smaller end of the second optical waveguide and the photonic device.

24. The apparatus of claim 18 wherein the first semiconductor material includes silicon oxynitride (SiON) and the second semiconductor material includes silicon (Si).

25. The apparatus of claim 21 wherein the antireflective region includes silicon nitride (Si_3N_4).